REPORT ON THE CASES ADMITTED TO THE CITY OF GLASGOW SMALL-POX HOSPITAL, BELVIDERE, DURING THE EPIDEMIC OUTBREAK IN THE YEARS 1892-95, BY ROBERT S. THOMSON, M.D., B.Sc., AND ERNEST L. MARSH, M.B., D.P.H. (OXON.).

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IT is our object to include within the limits of this report only those cases admitted to the City of Glasgow Small-Pox Hospital, Belvidere, during the epidemic prevalence of small-pox which extended from August, 1892, till December, 1895. During this period the annual admissions and deaths from this disease were as follows :

Year.	Admissions.	Deaths.
1892	73	5
1893	369	25[1]
1894	49	5
1895	236	20[2]
TOTALS,	727	55

In 1892, previous to the occurrence of the outbreak, there was one case of small-pox treated in the hospital, and in the early months of 1896 six cases were under treatment, but as these were independent and imported cases, and had no direct connection with the epidemic, they have been intentionally omitted from our record. Excepting a few treated in Knightswood Hospital, the above statement includes all the cases connected with the outbreak.

[1] One of these cases died of phthisis pulmonalis.
[2] One of these cases died of chronic bronchitis and emphysema.

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During the epidemic period there were admitted to the hospital in all 858 persons, of whom 784 were certified to be suffering from small-pox, 66 as suffering from chicken-pox, while 8 were healthy mothers admitted with infants on the breast. Of the total admissions, however, only the above enumerated 727 cases were decided on observation to be undoubted cases of small-pox, the remaining 123 patients suffering from diseases other than small-pox.

The following analysis gives an idea of the miscellaneous diseases admitted :

Disease as Certified on Admission.	Disease as Diagnosed after Admission.	Cases Admitted.	
		Small-Pox.	Others.
Small Pox (784 cases), .	*Small-Pox*, ...	722	...
Do., . . .	Chicken-Pox, . . .	...	18
Do., . . .	Syphilis, ...	...	12
Do., . . .	Nothing, ...	...	9
Do., . . .	Measles, ...	...	8
Do., . . .	Eczema, ...	...	3
Do., . . .	Scabies, ...	...	2
Do., . . .	Febricula, . . .	...	2
Do., . . .	Lichen, ...	...	2
Do., . . .	Gangrene { (a) of Leg, . 1 { (b) of Penis, 1	...	2
Do., . . .	Post-Vaccinal Eruption, .	...	1
Do., . . .	Acute Rheumatism, . .	...	1
Do., . . .	Acute Pneumonia, . .	...	1
Do., . . .	Scarlet Fever, . . .	...	1
Chicken Pox (66 cases),	Small-Pox, ...	5	...
Do., . . .	Chicken-Pox, . . .	...	60
Do., . . .	Syphilis, ...	...	1
		727	123
	Nursing Mothers, . .	...	8
	TOTAL, . . .	858	

From this it will be seen that of the 784 cases certified small-pox, 62 (or 7·9 per cent.) were wrongly diagnosed ; and of the 66 cases certified chicken-pox, 5 (or 7·6 per cent.) proved to be suffering from small-pox. Besides these mistakes in diagnosis discovered in the Small-Pox Hospital, cases were occasionally admitted to the adjacent Fever Hospital certified

measles, enteric, or typhus fever which were found to be small-pox.

This experience helps to illustrate the difficulty which so frequently attends the diagnosis of small-pox, a difficulty greatest in the early phase of the eruption, or when it presents itself in a modified form ; for in the former case the disease is apt to be mistaken especially for syphilis and measles, while in the latter varicella presents the principal element of confusion. In those cases mistaken for measles, enteric, or typhus, the confusion arose from failure to distinguish the prevariolar eruption of the morbilliform and petechio-erythematous types from the exanthem which they simulated.

It was the realization of the above probabilities of confusion that prompted the sanitary authorities to encourage the notification of all cases, especially varicella, which presented any reasonable resemblance to small-pox, and this will naturally occur to the mind as accounting for the large proportion of chicken-pox cases admitted to the hospital. Outside the primary consideration of the public safety, the practice of admitting doubtful cases may be open to theoretical objections, especially when an "observation ward" is not in use ; but, as will be seen later on, the experience of the hospital during the epidemic under consideration showed that, as the result of prompt and careful revaccination, any risk fades away to vanishing-point.

We do not intend at present to speak of the preventive measures against small-pox invasion that have been so systematically developed by the responsible authorities in Glasgow, nor do we intend to dwell on the special measures adopted during the actual epidemic prevalence of the disease. But we would point out that the responsibility for the city's preparedness in this respect falls directly upon one executive body— the municipal sanitary department. It is satisfactory that the advances on ancestral methods, both parochial and legislative, in dealing with small-pox, especially those involving the practice of vaccination and revaccination, have earned the confidence of the community generally. Thus vaccination and revaccination, associated with the isolation of patients and suspects in hospital and reception-houses, were utilized to the

ultimate protection against a critical outbreak of small-pox of a population exposed on all sides to the introduction of the disease.

The epidemic commenced by admission into the hospital on August 6, 1892, of a sailor who had recently arrived from Bilbao. On reaching Glasgow he took up his residence in one of the model lodging-houses close to the docks, where he sickened on the 27th July, ten days after leaving Spain. The disease was communicated by this patient to several inmates of the lodging-house in the first instance, and, within ten weeks, there were admitted to the hospital from various quarters of the city, about a dozen associated cases. It was possible, for a considerable time, to trace through sequences of infection the association of fresh cases with the first, but this feature of the outbreak was ultimately lost, partly as a result of the presence of missed cases, and partly from the intrusion of fresh cases from without which set up new centres of infection within the city. The investigations of the sanitary officials as to the origin of each case showed the outbreak to be rich in examples of infection communicated to all classes of the community—"to neighbours, to friends and relatives living at a distance who were casual callers, to fellow-workers, to employers, and to persons during the short and casual relationship of waiting to consult the same doctor."[1]

During the whole course of the outbreak, of the total number of small-pox admissions about 10 per cent. were drawn from the vagrant class—this term being used to indicate frequenters of model lodging-houses, shelters of various kinds, and prisons. The majority of these were removed from model lodging-houses, and were admitted to hospital during the earlier part of the epidemic. The smallness of this proportion is remarkable, considering the origin of the epidemic, and the circumstances and unhealthy relations of this class, and is probably to be accounted for by the large number who had served in the army, or had passed through prisons, poorhouses, and reformatories, and become thereby one of the best protected by vaccination in the community.

[1] Report by the Medical Officer of Health to the Committee on Health, Nov., 1892.

Of conditions other than vagrancy and direct contact with infection influencing the maintenance of the disease among the community that due to seasonal causes may be conveniently illustrated in the following table:—

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1892 .	...	...	...	...	...	...	...	3	5	10	38	17
1893 .	96	42	93	83	47	8	...	...	...	...	...	...
1894 .	1	6	14	20	5	1	1	...	...	...	...	...
1895 .	14	52	40	69	31	13	2	1	...	6	4	4

Here the alternate massing and thinning of the cases contemporaneously with obvious changes in meteorological conditions tempts to speculation as to the possible law regulating the undulatory movement observed during the epidemic. It must suffice, however, to point out that these results probably depend on the fact that, during the colder and darker months, overcrowding among the lower classes in a large city like Glasgow constitutes an important factor in the causation and spread of small-pox as of other zymotic diseases, this factor disappearing in direct proportion as the months become sunny and life less domestic.

A more controllable influence, and one which seriously affected the spread of the infection, was connected with the occasional tardiness with which the disease received medical recognition, and, in this connection, it is a matter of considerable interest and importance to note the period elapsing between the admission of the patient to hospital and the commencement of the initial stage of the illness. This period was found to vary within wide limits, some of the cases being admitted as early as the second day of illness, while others were not admitted till the twenty-second day or even later. The majority of the patients entered the hospital on the fourth, fifth, or sixth days of illness, i.e. soon after the characteristic eruption appeared; but a considerable number were identified and isolated only when the pustular stage was well advanced,

even though the patients were in some cases under constant medical observation in their own homes. The bulk of those admitted after the fourteenth day were cases " missed " in their earlier stages on account of the mildness of the attack leading the sufferers to think that they had some trifling ailment which did not demand medical advice. These cases were discovered mostly by the medical officers and epidemic inspectors after giving rise to secondary infections. The following scheme shows concisely the admissions as they occurred in relation to the day of illness :—

Day of illness on admission,	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Number admitted,	15	52	137	178	119	83	56	16	12

Day of illness on admission,	11th	12th	14th—21st	22nd.	No information.
Number admitted,	4	2	11	16	26

An analysis of the ages of those admitted shows a range from early infancy to advanced age—the great bulk of the cases, however, being persons from 20-40 years. This will be at once appreciated by a reference to the table on page 216, in which the age incidence is set down in annual periods up to five years, in quinquennial periods from 5-20 years, and in decennial periods from 20 years upwards.

It will be noticed that there were admitted in all 38 cases under ten years of age, or 5·2 per cent. of the total admissions. The smallness of this proportion will be better appreciated when it is remembered that, approximately, 24 per cent. of the community is made up of children under ten years. On the other hand, there were admitted 16 cases over fifty years of age, or 2·2 per cent. of the total admissions. This proportion at first sight seems small, but it should be noticed that, approximately, only 12 per cent. of the community is made up of persons of fifty years and upwards. But all these peculiarities of age distribution in small-pox relate mainly to vaccination, and can be discussed correctly only in reference thereto.

The disproportion between the males and females admitted amounted to over a fourth less females than males.

The case mortality over all during the epidemic was 7·6 per

SMALL-POX. TABLE SHOWING ADMISSIONS AND DEATHS AT VARIOUS AGES OF 727 CASES ADMITTED INTO THE CITY OF GLASGOW SMALL-POX HOSPITAL, BELVIDERE.

AGES.	MALES.			FEMALES.			TOTAL.		
	Cases admitted.	Died.	Mortality per cent.	Cases admitted.	Died.	Mortality per cent.	Cases admitted.	Died.	Mortality per cent.
Under 1	5	2	40·00	1	1	100·00	6	3	50·00
1–2	...	...	...	1	...	...	1	...	...
2–3	5	...	...	1	...	...	6	...	...
3–4	1	...	...	...	...	...	1	...	...
4–5	3	...	...	1	...	...	4	...	...
Total Under 5,	14	2	14·28	4	1	25·00	18	3	16·67
5–10	12	...	...	8	2	25·00	20	2	10·00
10–15	20	1	5·00	27	...	...	47	1	2·13
15–20	56	...	...	51	...	...	107	...	...
20–30	179	10	5·59	114	10	8·77	293	20	6·82
30–40	100	14	14·00	62	2	3·23	162	16	9·88
40–50	37	5	13·52	27	4	14·82	64	9	14·09
50 upwards	9	3	33·34	7	1	14·29	16	4	25·00
Total over 5,	413	33	7·99	296	19	6·42	709	52	7·34
Totals,	427	35	8·20	300	20	6·67	727	55	7·57

cent., the larger proportion of deaths being among the males, the percentage of fatality among males as compared with females standing as 8·2 to 6·7 per cent.

Vaccination Statistics of Cases of Small-pox admitted to the Hospital during the Outbreak.—The following table gives details as regards vaccination, revaccination, the character of the eruption, and the result in all cases of small-pox admitted during the course of the epidemic. Of the 727 cases admitted 643 were vaccinated, 12 being revaccinated in later life. Of these 23 died. Of unvaccinated cases there were 63 admissions with 27 deaths, while in 21 cases the evidence as regards vaccination was doubtful, and of these 5 died.

SMALL-POX IN PERSONS ONCE VACCINATED.

Age-Periods	Small-Pox in Unvaccinated Persons				Small-Pox in Doubtfully Vaccinated Persons				Area of Scars	One Scar									Two Scars									Three Scars									Four Scars									Small-Pox in Re-Vaccinated Persons					Totals
		Nature of Attack		Deaths		Nature of Attack		Deaths		Foveated			Unfoveated			Deaths		Foveated			Unfoveated			Deaths		Foveated			Unfoveated			Deaths		Foveated			Unfoveated			Deaths		Nature of Attack			Deaths	
	Discrete	Confluent	Haemorrhagic		Discrete	Confluent	Haemorrhagic			Discrete	Confluent	Haemorrhagic	Discrete	Confluent	Haemorrhagic		Discrete	Confluent	Haemorrhagic	Discrete	Confluent	Haemorrhagic		Discrete	Confluent	Haemorrhagic	Discrete	Confluent	Haemorrhagic		Discrete	Confluent	Haemorrhagic	Discrete	Confluent	Haemorrhagic		Discrete	Confluent	Haemorrhagic		

Footnotes:

* Four of these cases were vaccinated during incubation period.
† One of these cases was vaccinated during incubation period.
‡ One of these cases had small-pox in infancy.
§ One of these cases were vaccinated during incubation period.
|| Died of chronic bronchitis and emphysema.
¶ Four of these cases died of phthisis pulmonalis.

While these figures give a general idea of the state of vaccination, mortality, etc., it will be shown that they require to be considerably modified to bring out the exact truth, especially as regards the mortality among the vaccinated and unvaccinated cases. Of the 23 deaths occurring among vaccinated persons, two were the result of diseases other than small-pox, the attack of small-pox in each case being mild. In one death was due to chronic bronchitis and emphysema, and the other was the result of phthisis pulmonalis. This leaves 21 (or 3·26 per cent.) deaths among vaccinated persons directly due to small-pox. It is of interest to note that none of the deaths occurred among revaccinated persons.

In the above table all cases unvaccinated *at the time of exposure to infection* appear in the column of "unvaccinated cases," but five of these were successfully vaccinated within a short time *after* exposure. In four of these the attack was very mild, and there is every reason to believe that the course was greatly modified by the process of vaccination. This opinion is based upon the extremely mild character of the attack in most of the cases so vaccinated as compared with that in those in whom no attempt at vaccination had been made, or in whom the attempt had failed. In three of the cases vaccination was performed from the tenth to twelfth day before the appearance of the eruption, in another after exposure to infection, but no information could be given as to the actual date, while in the remaining case the operation was performed on the eighth day before the appearance of the eruption, but apparently without exerting any modifying influence on the course of the attack, as the child died on the twelfth day of illness of confluent small-pox. In addition to the above, one of the unvaccinated cases had had small-pox in infancy, and presented on admission numerous pock-marks on the face and extremities. Thus we are left with 57 cases in which absolutely no attempt to vaccinate was made either before or after exposure to infection, and in which no protection was conferred by a previous attack of small-pox.

Under the heading "doubtful" are classed all cases where the patient was said to have been vaccinated in infancy, but

of which no evidence could be discovered, either as a result of defective vaccination or masking of the cicatrices by a profuse eruption. Of the 21 cases so classed one had a previous attack of small-pox in early adult life. This leaves us with 20 cases in which there was no evidence of previous protection.

Comparing the rate of mortality of these unquestionably non-vaccinated, doubtfully vaccinated, and vaccinated cases, we get the following result :—

	Cases.	Died of Small-Pox.	Mortality per cent.
Unvaccinated,	57	26	45·6
Doubtful,	20	5	25·0
Vaccinated,	643[1]	21	3·3

In other words, the rate of mortality of unvaccinated cases was about fourteen times that of the vaccinated, and nearly double that of the doubtful cases ; while the rate of mortality among doubtful cases was about eight times that of the vaccinated cases.

Comparing the rate of mortality among vaccinated and un-vaccinated persons according to age, and excluding the two deaths among the vaccinated due to phthisis and chronic bronchitis, the five cases vaccinated while incubating the disease, and the unvaccinated case which had had a previous attack of small-pox, we get the following result :

AGE-PERIODS.	VACCINATED.			UNVACCINATED.		
	Cases.	Deaths from Small-Pox.	Mortality per cent.	Cases.	Deaths from Small-Pox.	Mortality per cent.
0–5	6	...	...	5	2	40·0
5–10	10	...	...	8	1	12·5
10–15	43	...	...	4	1	25·0
15–20	103	...	...	3	...	...
20–30	270	11	4·07	15	6	40·0
30–40	144	6	4·16	14	9	64·2
40 +	67	4	6·0	8	7	87·5

Here it is of especial interest to observe that, among the vaccinated cases, no death occurred among 162 cases treated under the age of twenty years, whereas among 20 unvaccinated

[1] Includes the 12 revaccinated cases.

persons during the same period there were 4 deaths (or 20 per cent.), and this startling disproportion between the rate of mortality among vaccinated and unvaccinated persons is maintained as we advance in the age-periods.

Passing now from the consideration of the influence of vaccination upon the rate of mortality in small-pox, we will next consider what influence vaccination exerts upon the severity of the attack in so far as that can be gauged by the character of the eruption as set forth in the subjoined table, from which, for obvious reasons, we omit all reference to "doubtful" cases.

| AGE-PERIODS. | VACCINATED. | | | | | | UNVACCINATED. | | | | | |
| | Nature of Attack. | | | Percentages.[1] | | | Nature of Attack. | | | Percentages.[1] | | |
	Discrete.	Con-fluent.	Haemor-rhagic.	Discrete.	Con-fluent.	Haemor-rhagic.	Discrete.	Con-fluent.	Haemor-rhagic.	Discrete.	Con-fluent.	Haemor-rhagic.
0–5	6	...	...	100	...	...	...	4	...	...	100	...
5–10	8	2	...	80	20	...	3	5	...	37·5	62·5	...
10–15	43	...	...	100	...	...	1	3	...	25	75	...
15–20	111	2	...	98	2	...	·1	2	...	33·3	66·6	...
20–30	251	16	3	93	6	1	1	11	3	6·6	73·4	20
30–40	132	11	1	92	7·5	0·5	1	10	3	7	72	21
40 +	57	7	3	85	10	5	2	5	2	22·2	55·6	22·2
Totals,	608	38	7	93	6	1	9	40	8	15·8	70·2	14·0

Comparing the totals we find that, among 653 vaccinated persons, 608 (or 93 per cent.) presented a discrete eruption, while, among 57 unvaccinated persons, there were only 9 (or 15·8 per cent.) whose illness was of this comparatively mild type.

Turning now to the severe types of the disease, we find that only 38 (or 6 per cent.) of "confluent" and 7 (or 1 per cent.) of "haemorrhagic" cases existed among the vaccinated ; while among the unvaccinated there were as many as 40 (or 70 per cent.) of the former type, and 8 (or 14 per cent.) of the latter. Again, on massing and comparing the cases under the age of twenty when presumably primary vaccination still exercises a

[1] Percentages of Total at each Age-Period.

modifying influence over the course of the disease, we find that of 162 vaccinated persons, only 4 (or 2·4 per cent.) were "confluent," while, of 19 unvaccinated, 14 (or 74 per cent.) were of this type. This difference is too striking to require further comment.

Setting aside for the present the unvaccinated cases and comparing the proportions of confluent cases occurring among the vaccinated only in the age-periods above twenty years, we find a steady increase in the proportions, the figures being as follows : 20-30 years, 6 per cent. ; 30-40 years, 7·5 per cent.; over 40 years, 10 per cent., suggesting a gradual but steady decrease of the protection afforded by primary vaccination. What part, if any, is played by increasing age in the evolution of these figures would be very difficult to say, but it is noteworthy that, in comparing them with the same age-periods among the unvaccinated, we find the order reversed—the largest proportion of confluent cases occurring during the age-period 20-30 years—the sequence of the proportions being 73·4, 72 and 55·6 per cent. for each of the age-periods above twenty years. Doubtless the numbers on which the latter proportions are calculated (see table above) are small, but they are nevertheless very suggestive.

We would point out that among vaccinated persons a "confluent" eruption does not necessarily indicate a violent type of the disease, for in a number of cases the confluent eruption aborts before the pustular stage is reached, and in some cases part only of the elements of the eruption become even markedly vesicular. This is a condition we have never observed among unvaccinated confluent cases.

Proceeding now to investigate the protective influence of vaccination as indicated by the area and character of the scars among those only once vaccinated, we will find in the table on page 222 facts of a most suggestive kind. These measurements were invariably made at the time of dismissal of the patient from hospital.

Comparing in the first place the "foveated" with the "nonfoveated," we have to deal with a total of 503 of the former and 128 of the latter. The protective influence of vaccination as indicated by a "foveated" scar would appear

AREA OF CICATRIX.	FOVEATED.				UNFOVEATED.				TOTALS.			
	Discrete.	Confluent.	Haemorrhagic.	Died.	Discrete.	Confluent.	Haemorrhagic.	Died.	Discrete.	Confluent.	Haemorrhagic.	Died.
Class I.— Under ¼ sq. in.	29	4	1	3	18	8	3	6	47	12	4	9
Class II.— ¼ to ½ sq. in.	132	9	...	6	28	4	...	3	160	13	...	9
Class III.— Over ½ sq. in.	318	9	1	2	61	4	2	4	379	13	3	6
TOTALS,	479	22	2	11	107	16	5	13	586	38	7	24
Results in percentages of total cases in each class. — Cl. I.	85·0	12·0	3·0	8·8	62·0	27·6	10·4	20·7	74·6	19	6·4	14·3
Cl. II.	93·6	6·4	...	4·3	87·5	12·5	...	9·4	92·5	7·5	...	5·2
Cl. III.	97·0	2·7	0·3	0·6	91·0	6·0	3·0	5·9	96·0	3·3	0·7	1·5
TOTALS,	95·0	4·5	0·5	2·2	83·6	12·5	3·9	10·2	92·8	6·0	1·2	3·8

to be much greater than that represented by an unfoveated scar, for while among the former we find only

11 deaths, or a proportion of 2·2 per cent.

2 haemorrhagic cases, or a proportion of 0·5 per cent.

22 confluent cases, or a proportion of 4·5 per cent.,

among the latter these proportions are greatly increased, there being

13 deaths, or a proportion of 10·2 per cent.

5 haemorrhagic cases, or a proportion of 3·9 per cent.

16 confluent cases, or a proportion of 12·5 per cent.

The difference noticeable between the proportions of discrete cases belonging to these two classes is equally well marked, there being in the first or foveated class a total of 479 (or 95 per cent.) of discrete cases, and in the second or nonfoveated class 107 (or 83·6 per cent.).

Turning now to the question of scar area, we obtain results which point to the conclusion that the superficial area of the vaccinal cicatrix is an index of the degree of protection

afforded by vaccination.   Beginning with 63 cases showing a scar area measuring less than $\frac{1}{4}$ square inch, we find the total subdivided into 47 (or 74·6 per cent.) discrete cases, 12 (or 19 per cent.) confluent cases, and 4 (or 6·3 per cent.) haemorrhagic cases.   Of these cases 9 (or 14·3 per cent.) died.   Passing now to those cases with a scar area measuring from $\frac{1}{4}$-$\frac{1}{2}$ square inch, we find indications of a greater protective influence, for of a total of 173 cases, we get the large proportion of 160 (or 92·5 per cent.) discrete cases, while the proportion of severe cases is considerably reduced, there being 13 (or 7·5 per cent.) confluent cases, and no haemorrhagic cases.   In this second class there were only 9 deaths (or 5·2 per cent.).   Finally, when we investigate those cases, of which there was a total of 395, in which the scar area exceeded $\frac{1}{2}$ square inch, we find no fewer than 379 (or 96 per cent.) discrete cases, only 13 (or 3·3 per cent.) confluent cases, and 3 (or 0·7 per cent.) haemorrhagic cases.   Of the total of 395 cases belonging to this class only 6 (or 1·5 per cent.) proved fatal.   The influence of the larger scar area and its index for protection is brought out most markedly when we contrast the first and third classes.   In the former, with a scar area under $\frac{1}{4}$ square inch, we have 21·4 per cent. *fewer* discrete cases, and 15·7 per cent. and 5·6 per cent. *more* confluent and haemorrhagic cases respectively.   The disproportion between the death rates is equally marked, there being 12·8 per cent. *more* deaths in the first than in the third class.

Continuing our analyses, we have next to consider the influence of vaccination in so far as it depends on the *number* of scars, and the table on page 224 is intended to give some idea of the importance of this.

The most striking feature here is the great proportion of discrete as compared with confluent cases irrespective of the number of scars.   The disproportion between the total number of cases with three or more scars as compared with those having one or two scars would suggest a much greater protective influence conferred by the former as against a lesser number.[1]   Less striking, but still very obvious, is the influence

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[1] The obvious fallacy which may exist here is that the number of persons in the community having one, two, three or more scars is unknown.

Number of Scars.	Discrete Cases.	Confluent and Haemorrhagic Cases.	Deaths.
Class 1.—One Scar, . .	266	29	17[1]
Class II.—Two Scars, . .	247	12	5
Class III.—Three Scars+, .	73	4	1[2]
Totals, ...	586	45	23
Results in Percent- ⎧Class I.,	90·2	9·8	5·8
ages of total cases ⎨Class II.,	95·4	4·6	2·0
in each class, ⎩Class III.,	95·0	5·0	1·3
Totals, ...	92·9	7·1	3·6

of two scars and upwards as compared with one, a fact brought out not only by the increase in the proportion of discrete cases with an increase in the number of scars, but also by a progressive diminution in the proportion of confluent cases and deaths under the same influence.

The duration of a patient's illness from small-pox is to some extent a gauge of the severity of the attack, and hence the length of a patient's illness, calculated from the first onset of the initial symptoms till the date of dismissal from hospital, may be used to give at least general data as to the mildness or otherwise of the attack. It should be noted in this connection, however, that it is the practice of the hospital to detain even those suffering from the mildest forms of the disease till the twenty-eighth day from the first onset of symptoms. Of the total 727 recorded cases the date of the initial illness was available in all but seven. Taking the remaining 720 cases and classifying them according to their condition as to vaccination (see table, p. 217), we get the following information regarding the mean duration of the attack among those who recovered as well as among those ending fatally:

LENGTH OF ILLNESS.

	Vaccinated.	Doubtful.	Unvaccinated.
Recoveries, .	. 38·3 days .	. 51 days .	. 59·6 days
Deaths, .	. 12·7 ,, .	. 14·3 ,, .	. 12·3 ,,

[1] One of these deaths was due to phthisis pulmonalis.
[2] This case died of bronchitis and emphysema.

Here it will be observed that the " vaccinated " had an average duration of illness of almost two weeks less than the " doubtful," and rather over three weeks less than the " unvaccinated," while among the fatal cases the average duration of the illness was about the same in each class—the majority of the patients dying at the end of the second week of illness, a period corresponding with the acme of the attack. The approximate identity of these mortality figures in the different classes suggests the question whether the reduction of the " vaccinated " and " doubtful " to the same level with the " unvaccinated " does not point in the direction of a complete loss of the protective influence of vaccination among the first of those so far as fatal cases are concerned.

Revaccination.—Of the total admissions to hospital during the epidemic period only 12 were cases showing unmistakable signs of successful revaccination, though a number were admitted in whom revaccination was said to have been attempted on one or more occasions, but without success. Among the former the ages ranged from 20 to 45 years, 3 being persons between 20 and 30 years, 5 between 30 and 40 years, and 4 between 40 and 45 years. One of these patients had been revaccinated 38 years before admission, another 32 years, three 21 years, while the remaining seven were revaccinated 20, 16, 14, 13, 11, 10, and 7 years respectively before contracting small-pox. Each of these cases showed unequivocal and well-defined cicatrices, due to their secondary vaccination. All were, without exception, mild cases and recovered, the average duration of illness being 35 days.

In addition to these there were 13 cases admitted in whom revaccination had proved unsuccessful, and in each of these, with but two exceptions, the attempt to revaccinate was *recent*, and performed as a *prophylactic during the course of the epidemic*. With regard to the two cases mentioned as exceptions, there was no evidence of the operation beyond the patients' statements; among the others, in three cases there were distinct local signs of reaction ; but in the remaining eight no local effect followed upon the operation. It would seem that, in some of these cases, the failure of the revaccination was regarded as evidence of immunity, but the subsequent develop-

ment of small-pox showed clearly that such immunity did not
exist. The following table gives a short abstract of the more
important data concerning the 11 cases referred to as unsuc-
cessfully revaccinated :

Age.	Statement as to Primary Vaccination.	Interval between attempted Re-vaccination and attack of Small-Pox.	Lymph used and Result.	Character of Small-Pox Attack.
Years. 20	1 good scar dating from infancy.	21 days.	Conserve calf-lymph : no reaction.	Sparse eruption.
25	Said to have been done in infancy, but no scar visible.	Do.	Do., do.	Do., do.
26	2 good scars dating from infancy.	22 days.	Conserve calf-lymph : slight local reaction.	Rare eruption.
16	3 good scars dating from infancy.	30 days.	Conserve calf-lymph : no reaction.	Sparse eruption.
35	Do., do.	1½ months.	Human & calf-lymph (several attempts) : slight local reaction.	Rare eruption.
21	1 small scar dating from infancy.	2½ months.	Human lymph : no reaction.	Sparse eruption.
45	2 good scars dating from infancy.	3 months.	No information regarding lymph : no reaction.	Sparse eruption.
29	1 good scar dating from infancy.	3½ months.	Conserve calf-lymph : no reaction.	Copious eruption.
29	Do., do.	15 months.	Conserve calf-lymph : slight local reaction.	Rare eruption.
66	2 small scars dating from infancy.	16 months.	No information regarding lymph : no reaction.	Sparse eruption.
22	4 small scars dating from infancy.	36 months.	No information regarding lymph : no reaction.	Rare eruption.

It seems to us important to observe that the conserve of
calf-lymph employed in these cases was supplied by certain
makers under an unusual strain on their resources, and prob-
ably this accounts to some extent for the unsatisfactory results
obtained. The unreliable quality of this proprietary calf-
lymph led us to practise in all cases of urgency vaccination
with fresh humanized lymph which had undergone only a few
removes from the calf.

We now come to the consideration of revaccination *after
exposure to infection.* Taking thirteen days as fully repre-
senting the time occupied in the process of incubation among

the small-pox cases under discussion, the epidemic supplied us with 68 cases in which revaccination had been performed within this period. The interval between the date of attempted revaccination and the commencement of the initial symptoms of small-pox varied from 1 to 13 days, and, if this period of incubation be subdivided so that the effects of revaccination are considered within periods of 1 to 4 days, 5 to 8 days, and 9 to 13 days of sickening, we get the following results:

Length of time before Initial Symptoms of Small-Pox.	Negative Result.	Slight Local Re- action.	Apparently Successful Vaccinia.	Totals.
Class I.—1-4 days, . . .	16	7	...	23
Class II.—5-8 „ . . .	5	14	3	22
Class III.—9-13 „ . . .	8	9	6	23
Totals, ...	29	30	9	68
Results in percentages ⎱ Class I.	69·6	30·4	0·0	...
of Total Cases in ⎰ Class II.	22·8	63·6	13·6	...
each Class. Class III.	34·8	39·1	26·1	...
Totals, ...	42·7	44·1	13·2	...

Admitting that some of the samples of calf-lymph conserve used in revaccination were not altogether trustworthy, that the skill of the operators was not always perfect, and also that to a certain extent we are ignorant as to the conclusions to be deduced from the feeble result which so often follows revaccination, we still find from the above record of *successful revaccinations* that the proportion diminishes as we approach the commencement of the initial symptoms of variola—a fact which is of great significance in studying the influence of small-pox upon the local manifestations of vaccinia. The practical deduction from these facts is that we are encouraged to revaccinate even up to the eighth day after exposure to infection. The reasonableness of supposing that successful vaccinia running its course concurrently with the initial stages of small-pox will favourably modify the latter disease is borne out by our clinical

experience. This, expressed in general terms, was that of those in Class I., 26 per cent. were severe cases, those of a similar type in Class II. being reduced to 18·5 per cent., while in Class III. the proportion was as low as 13 per cent.

Before concluding this section of our paper, we consider it legitimate to say a word regarding the extraordinary immunity enjoyed by a community thoroughly protected by *recent* successful revaccination. During the period embraced within the limits of this report there were associated at various times with the hospital a total of no less than 456 persons in addition to the 727 suffering from small-pox. Of these 96 were officials of the hospital and 131 patients suffering from diseases other than small-pox, all living within the hospital precincts, and therefore in daily contact either with the patients themselves or with their infected clothing; while 229 students, physicians, etc., were only occasional visitors. In addition to these, 3 persons entered the precincts of the hospital, but did not come into contact either with the patients themselves or their infected clothing. Of these one was a tradesman who refused revaccination and afterwards entered the hospital without permission of the officials; the second was an ambulance driver belonging to the adjacent fever hospital who occupied a room contiguous to that used by some of the male servants of the small-pox hospital, while the third was a young woman who visited the matron with regard to a vacant situation. Of the above total of 459 persons, 454 had been successfully revaccinated or were regarded as immune on account of failure to revaccinate, one had had small-pox in earlier life, while 4 were persons who had been primarily vaccinated only. Of the 459 persons referred to, 7 contracted small-pox. These included the 4 persons once vaccinated, 2 who were regarded as immune on account of failure to revaccinate, and one who had been successfully revaccinated twenty years previously. With one exception, that of a male aged thirty, who had been vaccinated in infancy only, all these cases were extremely mild, and none died. It is satisfactory as well as interesting to note that no case of small-pox occurred among those who had been successfully revaccinated within a recent date.

SUMMARY OF CLINICAL COMPLICATONS AND SEQUELAE.

Having now discussed in some detail the general clinical features manifested by the variolous patients admitted to the hospital during the epidemic, our record will tend to completeness if we refer briefly to the rarer complications and sequelae.

The complications and sequelae were observed almost exclusively in the severe types of the disease. Of these boils, abscesses of various sizes, cellulitis and periostitis were most frequently met with. Catarrhal conditions of the bronchial tubes, catarrhal pneumonia, and lobar pneumonia were not exceptional. Gangrene of the lungs occurred in several cases, and pleurisy in a few. Empyema was not met with in any case. Organic cardiac complications were very rare, only one case of acute endocarditis being attributable to the small-pox attack; but loud functional murmurs were very commonly present, especially in the more severe types of the disease. These latter mostly disappeared as convalescence became established. Albuminuria occurred in a considerable number of cases, though actual organic disease of the kidney in only a few, two cases only being dismissed from hospital with persistent albuminuria. In a considerable number of the more severe cases, marked oedema of the lower limbs, without evidence of either renal or cardiac implication, persisted for a time after the patients were allowed to get about. Inflammation of the veins of the legs occurred in three cases. Phlyctenular ophthalmia and mild ulcerative conditions of the eye were not uncommon, but only one patient lost the sight of an eye.

Nervous sequelae showed themselves in three young male adults; in two this took the form of mental disturbance, while the third was probably a form of peripheral neuritis. In one of the former the aberration occurred during early convalescence, when the patient manifested more or less maniacal symptoms with delusions. The second case presented symptoms of post-febrile dementia. Both ultimately recovered after a term of residence in an asylum. The third case was that of a patient, aged twenty-five, vaccinated, and with a sparse eruption, who, in early convalescence (tenth day of illness), complained of

weakness and numbness in the right arm and of tenderness in the shoulder-muscles and biceps. On examination there was distinct paresis of the muscles of the arm and extensors of the forearm, but sensation was unimpaired. The muscular weakness gradually became more marked till about the nineteenth day of illness, when improvement set in, and continued till patient's dismissal on the thirty-sixth day of his illness, at which time there were still distinct signs of diminished muscular power. There was no opportunity of examining the affected muscle electrically.

One of the most serious complications which had to be dealt with was connected with the pregnant state. Among a total of 261 women over 15 years of age admitted to the hospital, 23 (or almost 9 per cent.) were more or less advanced in pregnancy, and of these pregnancies 9 (or 39 per cent.) ended either in abortion or in premature labour. The mortality among those once vaccinated in infancy was about 20 per cent. (4 deaths among 21 cases), while in the only two unvaccinated cases death followed on the abortion.

In all the cases which proved fatal, the eruption was of the confluent type, but in the three that recovered it was only sparsely distributed. These benign cases had been revaccinated shortly after exposure to infection and each showed a mild concurrent vaccinia. Death of the mother and foetus occurred in the two unvaccinated subjects about the third and fifth month respectively, and at the fourth, sixth, seventh, and eighth month respectively in the vaccinated. The three non-fatal cases aborted about the fourth month of pregnancy. In two of these latter the abortion occurred on the twenty-seventh and twenty-eighth day of illness respectively, while the third took place during the prodromal stage. Of the fatal cases one aborted in the prodromal stage and the rest during the period of suppuration (seventh to twelfth day of illness). In only one instance was the infant born alive, viz. at the seventh month and on the twelfth day of the maternal illness. This infant lived for five days, and was vaccinated shortly after birth, but without success.

The 14 pregnant women who did not abort or miscarry had each been vaccinated in infancy, and all recovered. In

only four instances was the eruption other than sparse or rare
in amount. The majority of these pregnancies, viz., ten were
at the seventh or eighth month of gestation, the remaining
four being from the fourth to sixth month.

Besides the above there were 4 women admitted in the
early puerperal state. These patients had been vaccinated in
infancy and now suffered from modified attacks of small-pox,
from which they recovered. In each instance labour had
coincided with the occurrence of the prodromal symptoms of
the disease. All the infants were lost: one being born dead
a little before full term, two though born at natural time only
survived birth by a few hours, and one died of inanition and
gangrenous inflammation of the right leg nineteen days after
birth. This last was vaccinated a few hours after birth, but
as the attempt showed no definite reaction after four days the
operation was repeated, and was followed by the ultimate
success of both attempts.

Many marked examples of the induction of irregular men-
struation and metrorrhagia as a result of the attack of small-
pox occurred in the experience of the female wards.

No.	Sex and Age.	Vaccinated or Not.	Character of Eruption.	Day of illness when first Inoculated.	Total Quantity of Serum Employed.	Termination.	Remarks.
1	Male, 22	In infancy	Copious	5th	30 c.c.	Recovery	Urticaria 7 days after infection: "pitting."
2	Male, 20	Do.	Sparse	5th	10 c.c.	Recovery	...
3	Female, 55	Do.	Copious	6th	30 c.c.	Recovery	...
4	Male, 21	Do.	Copious	6th	20 c.c.	Recovery	"Pitting."
5	Female, 25	Unvaccinated	Haemorrhagic	6th	40 c.c.	Death	On 9th day of illness.
6	Male, 33	In infancy	Copious	5th	20 c.c.	Recovery	Boils and abscesses during convalescence :
7	Male, 16	Do.	Copious	4th	20 c.c.	Recovery	"pitting."

Treatment.—The only interest in this connection centres
round a few experiments carried out with the object of demon-
strating the therapeutic value of " variola antitoxic serum."

Details of these observations have already appeared elsewhere,[1] the table on page 231 being but a short summary of the cases so treated.

The conclusion arrived at was, in brief, that the serum, in small doses, such as employed by us, in no way modified the course of the attack; and that any therapeutic effects likely to result from this form of treatment must follow upon the administration of large doses, say from 20-30 oz. of serum as at present prepared.

Summary of Post-Mortem Examinations.—These examinations were conducted partly by members of the medical staff of the hospital, but principally by Drs. Sutherland and Ferguson, assistants to the Professor of Pathology in the University. In the great majority of the cases death was distinctly traceable to cardiac failure, the internal organs showing almost without exception evidence in a greater or less degree of passive hyperaemia. This was especially evident in the lungs where hypostatic congestion with oedema, and sometimes consolidation of the lower lobes, was present in almost every instance. In addition to these pathological changes directly due to small-pox itself, and more or less present in every case, there were present in some of the cases tissue change which might be regarded more distinctly as complicative, *e.g.* pneumonia, etc., and yet others, *e.g.* phthisis, present probably long before the attack of small-pox commenced, and which must be regarded rather as concurrent conditions than complications. What part these latter played in the course of the disease it is difficult to say, but there seems little doubt that the chances of recovery of a patient handicapped by these concurrent conditions were distinctly diminished. It is worthy of note that the majority of patients so handicapped were vaccinated subjects.

In none of the examinations did the *heart* show any evidence either of endo- or pericarditis, but effusion of serum into the pericardial sac, sometimes in considerable quantity, was not infrequent. Punctiform haemorrhages under the pericardium and endocardium were commonly found in the haemorrhagic cases. In only one case was there distinct naked-eye evidence of degeneration of the cardiac muscle. In several cases atheroma of

the aorta and its valves with *calcareous* degeneration was present. Dilatation of the cavities, especially those of the right side, was not infrequent.

Distinct evidence of pleurisy was present in four cases, but only in one of these were there indications of purulent change in the fluid.

In several cases slight hydro-thorax was present. Lobar pneumonia, in the stages of red and grey hepatization, was found in four cases, and catarrhal pneumonia in seven, the lesion varying from a few scattered patches of consolidation up to an extent involving practically a whole lobe or even more.

Gangrene of the lungs occurred in only two cases, and took the form of numerous ragged cavities, practically riddling the lungs and varying in size up to $1\frac{1}{2}$ in. in diameter. These cavities apparently originated in catarrhal patches connected with the ultimate bronchial distribution, probably primarily caused by insufflation of putrid particles. Concurrent tubercle of the lungs was found in eight cases, in several of these cavities were present, in others cicatrices and calcareous masses: of these six were vaccinated and two unvaccinated. In the two unvaccinated cases there was distinct evidence of glomerular nephritis. Fatty liver was frequently noted.

In none of the cases was there anything found in the brain or meninges, and in none of the other organs was anything worthy of note found beyond what has already been referred to

TABLE(S)
RUN INTO
GUTTER